Subways - Introductory Overview - Teacher Doc

Algebra and Choreo Graph

Project Introduction
In this project students will use Choreo Graph to explore algebraic concepts in a playful way that will be meaningful to them. In each lesson students will use the concepts - linear equations, coordinates, the distance formula, coordinate translations, efficiency and more - to examine the subway maps they design. Collectively, the lessons build toward designing a new map with emphasis on maximum efficiency.

There will be many opportunities for students to work collaboratively and share with the class their observations, discoveries and new ideas around designing their subway systems.
About the Subway Lessons
Lessons have been designed to either be a complete unit Lesson 1 through 6, or as stand alone lessons. We also encourage you to change the lessons to fit your needs. Throughout the lessons are tips to help teachers adapt the existing lessons for their needs. This could include scaling up and down grade levels, bringing out more math, more design or art, etc.

What students will do, in a nutshell
The map that is provided shows the subway stations that have been planned for the city, and also includes a few landmarks, museum, hospital, and school. Using Choreo Graph Students will take a picture of the blank map and draw subway lines connecting all the stations the city. (Note the sample subway map, pictured above.) The barrier in the map represents a part of the city that cannot be tunneled under. Each lesson guides students to explore the mathematics in their own map all with the intention to help them create a newer, more efficient map. In the final lesson, an earthquake has hit the town and students are tasked with starting from scratch with a few new barriers. Students will be prompted to consider the mathematics from the previous lessons to create the most efficient map possible, and to be able to back it up with coordinate notation, linear equations, and the distance formula as a part of their report.

Where’s the Math?
Designing subway maps in Choreo Graph is great for a variety of reasons. For one thing, trains are on rails, and Choreo Graph is well-suited to help students quickly create a network of lines that look very much like an actual subway map. Since the app includes a grid that shows (x, y) coordinates, and represents the translations in different color paths, there is an immediate collection of coordinates and line segments ready for exploration. A variety of topics are explored in this project, see below for more detailed information.

General description of the project across the lessons (Detailed lesson plans also included with each lesson.)
- In Lesson 1, students will create their first starter map.
- In Lessons 2-5 students will explore the math in the starter map, add local stations, find distances, learn about coordinate translations and linear equations, all with an eye on efficiency. (ie minimizing travel time, maximizing passenger capacity, etc.)
- In the culminating Lesson 6, students will be given a budget, and all sorts of new information, costs, speeds, etc. With an altered map to build on, (there’s been an earthquake!) students will design a new transportation system that needs to come in under budget and be efficient. They will report their plans to the class.

Learning Activities & Objectives

<p>| Lesson 1: Make your first map | Activity: Getting started by connecting all the stations and creating the first subway map to be used in the lessons to come. |</p>
<table>
<thead>
<tr>
<th><strong>Objective</strong></th>
<th>SWBAT to explore Choreo Graph’s interface while solving a real-world problem</th>
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| **Lesson 2:** Coordinate Translations | **Activity:** Students will learn how to represent each line segment as a coordinate translation in the form: \((x-h, y-k)\) and how this is a helpful notation to get started exploring efficiency of their map design.  
**Objective:** SWBAT represent geometric translations using coordinate notation. |
| **Lesson 3:** Distance Formula | **Activity:** Students will learn the distance formula and find distances between stations, landmarks, and will start to think about minimizing traveling distances.  
**Objective:** SWBAT apply the distance formula to real-world distance problems. |
| **Lesson 4:** Linear Equations | **Activity:** Students will add three new local stations to their map, and will need to find linear equations in the form \(y = mx + b\) to show that each local station is indeed on the line between two given express stations.  
**Objective:** SWBAT use linear equations to analyze their subway map. |
| **Lesson 5:** Efficiency | **Activity:** Students will take what they learned from lessons 1-4, and make some changes to their map that will increase efficiency. Minimizing distance and time to travel around the city.  
**Objective:** SWBAT edit and modify their subway maps in order to maximize the efficiency of their system. |
| **Lesson 6:** Design efficient new map after the Earthquake | **Activity/Assessment:** Students will start with a blank slate, a new map, and from the beginning will incorporate lessons 1-5 to design the most efficient subway system possible. They will also need to think about their budget and prepare a few reports about the efficiency of their new citywide transportation system.  
**Objective:** SWBAT apply their understanding of the Choreo Graph app and key algebraic concepts in solving a real-world problem. |

**What you need to get started**  
A set of iPads with the Choreo Graph app
Paper, pencil, markers to draw their subways trains
Or, instead sketching trains, you may use provided pictures of trains, or provide your own

**Time Needed**
Lesson 1 with introduction: 30 minutes
Lessons 2 - 5: 20 - 40 minutes each
Lesson 6: 40 - 180 minutes

**Collaboration and Group Work**
These lessons are designed for students to work individually, in pairs, or in groups. Each student should do all the work on their own sheets, and the iPad should be shared across group members as equally as possible.

We suggest that groups be no larger than four students. Four or more students in a group will require extra attention to make sure that every group member is contributing equally.

Enjoy the Subway Lessons!